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Instantaneous velocity worksheet

Instantaneous velocity questions and answers pdf. Instantaneous velocity worksheet with answers. Average vs instantaneous velocity worksheet. Instantaneous velocity for dummies. Instantaneous velocity pdf. What is a instantaneous velocity. Average velocity and instantaneous velocity worksheet. Instantaneous velocity questions and answers. Instantaneous velocity questions.

By the end of this section, you will be able to grasp the distinction between average velocity and instantaneous velocity. Additionally, you will learn how velocity differs from speed, and how to calculate both given mathematical equations. This section delves into the physics of motion, providing a crucial foundation for later chapters. The concept of velocity as an object moves continuously through space and time is addressed in this section. The quantity that measures how fast an object is moving at any point along its path is known as instantaneous velocity. It represents the average velocity between two points on the path as the time (and thus displacement) between these points approaches zero. Mathematically, we express position x as a continuous function of t, denoted by x(t). The expression for average velocity using this notation is [latex] \overset{\text{–}}{v}=\frac{x({t}_{2})-x({t}_{1})}{{t}_{2}-{t}_{1}} [/latex]. To find the instantaneous velocity at any position, we let [latex] {t}_{1}=t [/latex] and [latex] {t}_{2}=t+\text{Δ}t [/latex]. By taking the limit as [latex] \text{Δ}t\to 0 [/latex], we derive the expression for instantaneous velocity: [latex] v(t)=\underset{\text{Δ}t\to 0}{\text{lim}}\frac{x(t+\text{Δ}t)-x(t)}{\text{Δ}t}=\frac{dx(t)}{dt}. [/latex] The instantaneous velocity of an object is the limit of average velocity as elapsed time approaches zero or the derivative of x with respect to t: [latex] v(t)=\frac{d}{dt}x(t). [/latex] Like average velocity, instantaneous velocity is a vector with dimension length per time. The instantaneous velocity at a specific time point [latex] {t}_{0} [/latex] is the rate of change of the position function x(t), which is the slope of the position function x(t) at [latex] {t}_{0} [/latex]. The instantaneous velocity of an object occurs at specific points in time, typically when the slope of its position graph is either maximum or minimum. At these instances, the instantaneous velocity is zero due to the slope being zero. However, at other times, the instantaneous velocity is not zero as the slope of the position graph changes sign. The object's movement has taken a U-turn, and its velocity is now in the opposite direction. Most people tend to confuse speed and velocity in everyday conversations. However, in physics, these terms have distinct meanings due to their different characteristics. Speed, being a scalar quantity, does not take into account any directional aspects; it simply indicates how fast an object is moving. We can calculate average speed by dividing the total distance traveled by the time elapsed. For instance, if you're on a road trip and want to know your average speed, you'd divide the total distance covered by the time taken. On the other hand, velocity combines both speed and direction. The average velocity is found by dividing the magnitude of the total displacement by the elapsed time. A zero total displacement means an average velocity of zero, even if the average speed isn't zero. For example, if you take a trip that starts and ends at the same location, your average velocity will be zero, but your average speed won't. Instantaneous speed can be calculated from the magnitude of instantaneous velocity. If two particles are moving along the same axis at +7.0 m/s and -7.0 m/s, they have different velocities but the same speed of 7.0 m/s. Some common speeds include walking pace (1.7 m/s), cycling (4.4 m/s), running sprint (12.2 m/s), rural speed limits (24.6 m/s), official land speed records (341.1 m/s), and even the speed of light in a vacuum (299,792,458 m/s). To calculate instantaneous velocity, we need to specify the position function x(t) explicitly. Using polynomials like x(t)=Atn is helpful because they can be easily differentiated using the power rule of calculus: dx/dt = nAt^(n-1). Using the position function x(t)=3.0t+0.5{t}^{3}\,\text{m} , we first calculate the instantaneous velocity v(t) by taking the derivative of x(t). This results in v(t)=\frac{dx(t)}{dt}=3.0+1.5{t}^{2}\,\text{m/s}. To find the instantaneous velocity at t=2.0 s, we substitute this value into v(t), giving us v(2.0\,\text{s})=[3.0+1.5{(2.0)}^{2}]\,\text{m/s}=9.0\,\text{m/s}. Next, to determine the average velocity between 1.0 s and 3.0 s, we find the values of x(1.0 s) and x(3.0 s). Substituting these values into the equation for average velocity gives us \overset{\text{–}}{v}=\frac{x(3.0\,\text{s})-x(1.0\,\text{s})}{t(3.0\,\text{s})-t(1.0\,\text{s})}=\frac{22.5-3.5\,\text{m}}{3.0-1.0\,\text{s}}=9.5\,\text{m/s}. Significance The value of \overset{\text{–}}{v} converges to the value of v as the time interval goes to zero. The particle's movement can be described with an equation x(t) = -3t^2 m. At the start, t = 0, its position is zero and then becomes negative. After 1.0 s, it returns to the starting point where it began. Comparing the graphs of position, velocity, and speed helps in identifying errors in calculations. The slope of the position graph represents the velocity. A comparison between the slopes of the tangent lines at different times with the values for velocity shows they are equivalent. Speed is always positive and can be found by taking the absolute value of velocity. To find the velocity as a function of time, we take the derivative of the position function x(t) = -3t^2 m. This yields v(t) = -6t m/s. The velocity becomes negative at t > 0 due to its movement in the negative direction. At t = 1.0 s, the velocity is v(1) = -6 J/m/s and the speed is |v(1)| = 6 J/m/s. This indicates that even though the velocity might be positive for part of the journey, it's always negative when considering its direction. Instantaneous velocity gives the velocity at any point in time and can be calculated by differentiating the position function. Instantaneous speed, on the other hand, is always positive and obtained by taking the absolute value of instantaneous velocity. Average speed is determined by dividing total distance traveled by elapsed time, which distinguishes it from the magnitude of average velocity. The speedometer of a car measures speed rather than velocity because it doesn't account for direction. Calculating the total distance traveled divided by elapsed time would give you the average speed, not the magnitude of average velocity. These two quantities are the same only when there is no change in direction during travel. How do instantaneous speed and average velocity relate to each other? A woodchuck moves 20 m to the right in 5 s and then turns, moving 10 m to the left in 3 s. (a) What's its average velocity? (b) What's its average speed? Next, sketch the velocity-versus-time graph based on the following position-versus-time graph. Lastly, given the velocity-versus-time graph, draw the position-versus-time graph. An object has a position function x(t) = 5t m. (a) What's the velocity as a function of time? (b) Graph both the position and velocity functions. A particle moves along the x-axis according to x(t)=10t-2{t}^{2}\,\text{m}. (a) What's the instantaneous velocity at t = 2 s and t = 3 s? (b) What's the instantaneous speed at these times? (c) What's the average velocity between t = 2 s and t = 3 s? Unreasonable results. A particle moves along the x-axis according to [latex] x(t)=3{t}^{3}+5t\text{} [/latex]. At what time is the velocity of the particle equal to zero? Is this reasonable?